size just convenient to accommodate the entrance of the steel needle into the capillary tube. The needle, 3 cm. long and about 2/5 mm. in diameter, is soldered on to a finely-threaded thumb-screw (*t.s.*) which operates in a brass tube (*b.t.*). This tube is screwed firmly into the base of an "outer" brass cap (*o.b.c.*). In the inner end of the brass tube, the needle passes through a hole having a diameter the same as that in the steel disk. Into the "outer" cap is fit very closely a soft rubber cylinder (*r.c.*), in length one half that of the cap, through the center of which passes the needle. Inserting the needle into the hole in the steel disk, the "outer" cap is now screwed tightly on to the "inner" cap.

The device is supported and adjusted on the microscope stage by means of the Barber pipette-holder.

After the capillary tube and pipette are filled from a column of mercury contained in the rubber tubing (*rt.*), the system is then closed by the stopcock and is ready for operation. This is accomplished by regulating the thumb-screw which is threaded 60 turns to the inch. Very slight movements of it induce gradual changes of the meniscus of mercury in either direction in the tip of the micropipette (having a lumen of about five microns); these changes may be so delicate as to be almost imperceptible under a magnification of 400 diameters.

Two precautions are here worthy of note, viz., the use of glass tubing and mercury which are thoroughly clean, and the avoidance of air-bubbles anywhere within the system. To clean glass tubing, I have found the following method very effective: after sealing one end of the tube, put into it a few drops of 95 per cent. alcohol and a like amount of concentrated HNO_3. Upon adding a drop or two of H_2SO_4, an explosive reaction occurs which apparently oxidizes thoroughly any substances adhering to the surface of the glass. (The tube, of course, should be turned away from one's face before adding the H_2SO_4.) Break off the sealed end and wash the tubing well with distilled water.

To hasten the filling of the system with mercury and to remove air that may appear, it is advisable to fill nearly full the capillary tube (and add a drop of dust-free, distilled water which can be forced through the pipette point more easily than mercury) just before sealing in the pipette.

It is advantageous, also, to have the shank of the pipette fit fairly well the bore of the tube; air-bubbles are then less likely to appear in the sealing-wax between the shank and the surface of the bore.

The needle-pipette operates inside a moist chamber similar in design to that described by Chambers (*loc. cit.*). Distilled water or solutions of any sort for injection purposes may be drawn into the pipette after the mercury has been forced to the tip by turning the thumb-screw, then dipping the tip into a hanging drop of the solution and drawing a desired quantity of this into the pipette by reversing the movement of the screw. Obviously, cleansing with distilled water, which is sometimes essential, may be done in a similar way.

To extract cytoplasm or to remove a nucleus, a small amount of distilled water is drawn into the pipette, the tip then inserted into the organism and the operation completed by carefully manipulating the thumb-screw.

C. V. Taylor
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THE AMERICAN PHILOSOPHICAL SOCIETY. III

SATURDAY, APRIL 24

Executive Session—9:30 o'clock

Stated Business.—Candidates for membership balloted for. Appropriations for the ensuing year passed. Annual address of the president.

Morning Session—10 o'clock

George Ellery Hale, Ph.D., Sc.D., LL.D., vice-president, in the chair

The problem of the evolution of the solar system: Ernest W. Brown, Sc.D., professor of mathematics, Yale University.

Certain aspects of recent spectroscopic observations of the gaseous nebulæ which appear to establish the relationship between them and the stars: W. H. Wright, astronomer, Lick Observatory.

(Introduced by Professor Robert G. Aitken.) The paper summarizes in non-technical terms the evidence afforded by a study of the stellar condensations in the planetary or small gaseous nebulæ, which are shown to be spectroscopically identical with stars of the Wolf-Rayet group (Pickering's Class O). A brief account is given of some of the present day conceptions of stellar evolution, for the purpose of indicating the somewhat critical nature, with respect to these ideas, of the relationship indicated. A complete account of the investigation, of which the paper summarizes a part, is given in Volume XIII., part 6, of the Publications of the Lick Observatory.

The Einstein theory: EDWIN PLIMPTON ADAMS, Ph.D., professor of physics, Princeton University. Following Newton's statement of the law of universal gravitation, the goal of all physical explanations of natural phenomena was to reduce them to actions at a distance between elements. After Maxwell showed that electric and magnetic phenomena could be accounted for by a system of pressures and tensions in a universal medium—the ether—the goal changed, and the attempt was made to explain physical phenomena by direct action through a medium. Attempts to account for gravitational forces, however, in this way met with little success. The extension, by Einstein, of the principle of relativity and the resulting revision of the concepts of space and time, led to Einstein's interpretation of gravitation as a property of space itself when modified by the presence of matter.

The results of geophysical observations during the solar eclipse of May 29, 1919, and their bearing upon the Einstein deflection of light. (Illustrated): LOUIS A. BAUER, Ph.D., Sc.D., director of the department of terrestrial magnetism, Carnegie Institution of Washington. This paper is a continuation of the one presented at a stated meeting of the society on February 6, 1920. In that paper[1] a résumé was given of the geophysical and astronomical observations concerning the solar eclipse of May 29, 1919, and the Einstein effect made by the various expeditions sent out by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and the various astronomical expeditions sent out by Great Britain, the Rio Janeiro Observatory, and the Smithsonian Institution. It was shown how the results of the geophysical observations may have an important bearing upon the complete interpretation of the astronomical observations showing the deflections of light during the eclipse. A brief analysis of the light deflections was given and it was pointed out that there were non-radial effects of such a systematic nature that they could not be accounted for by errors of observation. The present paper gives the results of a special study of the cause of the non-radial effects of the light deflections observed by the British expedition at Sobral, Brazil. It is shown that these non-radial effects may be completely accounted for by incomplete elimination of differential refraction effects in the earth's atmosphere. The same cause may apparently also explain why the observed radial deflections of light exceeded, on the average, by about 14 per cent. the amounts predicted on the basis of the Einstein law of gravitation.

[1] "Observations in Liberia and Elsewhere of the Total Solar Eclipse of May 29, 1919, and Their Bearing on the Einstein Theory."

The high voltage corona in air: J. B. WHITEHEAD, professor of applied electricity, Johns Hopkins University. (Introduced by Dr. Pender.) The paper describes the nature of the corona and recent studies of the laws governing its appearance in high voltage circuits. Its influence as a limiting factor in long distance transmission occurs through deterioration of insulation and a leakage loss of power between the high voltage lines. The appearance of corona on a clean round wire is very sharply marked and may be used for the measurement of high alternating voltages to a degree of accuracy not heretofore possible. Experiments and observations on the corona voltmeter, an instrument devised for this purpose, are recorded; and an example of the instrument, suitable for voltages up to 300,000 volts, is described.

The velocity of explosive sounds: DAYTON C. MILLER, D.Sc., professor of physics, Case School of Applied Science, Cleveland. In 1918–1919 the writer had the privilege of making an extended series of experiments on the pressure waves from large guns in action, at Sandy Hook Proving Ground. One series of experiments was for the purpose of determining the variation in the velocity of the sound of the gun explosion as measured from the muzzle outward, and for the determination of the velocity of sound in free air. Most of the experiments were made in connection with 10-inch and 12-inch rifles, though a few were made with 6-inch and 8-inch guns. The amount of powder charge and the value of the internal pressure developed in the gun are taken into account. The sounds were received by means especially constructed carbon-granule microphones, while others

were of a very sensitive type. The records were made by an especially constructed moving-film camera in connection with a string-galvanometer capable of recording from six stations simultaneously, of the type used by our army for sound-ranging. Stations were located at the muzzle of the gun, and at points in front of the guns at distances of about 100, 200, 300, 400, 500, 600, 1,000, 2,000, 7,300 and 21,000 feet, six of these stations being used at one time. The locations were determined with precision. Meteorological observations were made by special observers in the distant stations and on the field near the guns, at the time of the experiments and continuous records were made at the Proving Ground Headquarters and at the United States Weather Bureau Station. These observations covered temperature, barometric height, humidity, wind velocity and wind direction. Measurements were also made of the velocity of the sound at a series of stations located on a line at right angles to the line of fire, and on a line at 45° to one side of the line of fire. In all, seventy-two sets of velocity determinations were made, eleven sets extending to the most distant stations at 21,000 feet from the gun, while the other sets relate to various groups of stations within 2,000 feet of the gun. Heretofore there has been a general impression that explosive sounds travel much farther than do ordinary sounds, the velocity being perhaps several times the normal velocity. These experiments show conclusively that the velocity at a distance of one hundred feet from a 10-inch gun is about 1,240 feet per second, or 22 per cent. above normal; at two hundred feet from the gun the velocity is only about 5 per cent. above normal. For all distances above five hundred feet from the gun the velocity of the explosive sound from the largest sized gun is practically normal. The value of the velocity of sound over the long range of 21,000 feet has not yet been calculated with all corrections applied, the preliminary value is in entire agreement with other determinations, and is about 1,089 feet per second at the freezing temperature. It is expected that the final value will be of a precision equalling the best heretofore obtained.

The U. S. navy MV-type of hydrophone as an aid and safeguard to navigation: Harvey C. Hayes, Ph.D., U. S. Naval Engineering Experiment Station, Annapolis. (Introduced by Professor John A. Miller.)

The transient process of establishing a steady alternating electric current on a long line from laboratory measurements on an artificial line: A. E. Kennelly, A.M., Sc.D., director, Research Division, Electrical Engineering Department, Massachusetts Institute of Technology, and U. Nabeshima. When a power-transmission electric conducting line is switched on to the generator at the power house, the alternating-current on that line settles down to a final state, under steady load, in a time which is theoretically indefinitely long, but which is usually practically covered in a small fraction of a second. The paper discusses the transient phenomena which occur along the line during this process of upbuilding the final current and voltage. The subject has been studied theoretically by a number of writers; but very few practical observations have been published concerning this transient state. It is known that the current and voltage do not build up steadily and continuously, but advance by little jumps which occur at regular short intervals of time, accompanying successive reflections of electromagnetic waves from one end of the line to the other. The authors present in the paper a number of observations which have been secured photographically, of the rise of voltage and current on a long artificial electric power-transmission line in the laboratory, and have compared the observed rates of growth with those which are indicated by theory, with a fairly satisfactory agreement. The observed results indicate the manner and mechanism by which electric power may be conceived of as being transmitted along such a line.

The strephoscope: N. W. Akimoff. (Introduced by Professor Eric Doolittle.)

New features in the eclipsing variable U Cephei: R. S. Dugan, professor of astronomy, Princeton University. (Introduced by Professor H. N. Russell.)

Arthur W. Goodspeed

(To be concluded)

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